

1 In the present invention, a compact burner
2 chamber employing a radiant burner assembly is
3 configured to distribute radiant energy along the
4 axial length of a tubular reaction chamber. In one
5 embodiment, the radiant burner assembly comprises a
6 woven metal fiber attached to a support structure that
7 permits the efflux of fuel and oxidant from the burner
8 core to the outer surface of the metal fiber. The
9 properties of the metal fiber stabilize the combustion
10 in a shallow zone proximal to the outer surface of the
11 metal fiber. The combustion reaction heats the metal
12 fiber to incandescence and provides a source of
13 radiant energy that is transferred to the reaction
14 chamber. In another embodiment, the radiant burner
15 assembly comprises a porous ceramic fiber burner that
16 accomplishes the same object by serving as a radiant
17 source of energy.

18 The metal fiber of the burner typically
19 consists essentially of an alloy containing
20 principally iron, chromium, and aluminum and smaller
21 quantities of yttrium, silicon, and manganese having
22 extended life at operating temperatures up to 2000°F.

1 In one embodiment, the tubular reaction
2 chamber has U-shape, and is sometimes referred to as a
3 hairpin tube, which is substantially filled with
4 catalyst, the tube extending into and out of the
5 combustion chamber for gaseous flow through. The
6 radiant burner axis is preferably vertically disposed
7 within the combustion chamber and oriented parallel to
8 the axis or axes of the U-tube reaction chamber. The
9 active radiant surface of the cylindrical radiant
10 burner assembly is defined by a geometric arc that
11 bisects the cylindrical assembly so as to maximize the
12 flux of radiant energy that is directed to the surface
13 of the U-tube reaction chamber. In this embodiment,
14 the center to center spacing between the radiant
15 burner and the U-tube reaction chamber, and the
16 radiation angle of the radiant burner are
17 simultaneously controlled, or configured for high
18 efficiency of heat transfer.

19 In a third embodiment, the tubular reaction
20 chamber comprises a helical coil that is substantially
21 filled with catalyst and has inlet and outlet portions
22 that pass into and out of the combustion chamber. The
23 helical coil is wrapped to form turns at specific lead

1 angles, so that the coil free area is in the range of
2 50% to 75%, wherein the free area is defined by the
3 ratio of the free area between helical tube conduits
4 or turns and the cylindrical surface that bisects the
5 helical coil circle or cylinder. The radiant burner
6 axis is typically vertically disposed within the
7 combustion chamber and the cylindrical radiant burner
8 is located at the center of the helical coil. In this
9 embodiment, the active radiant surface of the
10 cylindrical radiant burner assembly is defined by a
11 360-degree arc.

12 In each embodiment, the radiant burner is
13 operated at a combustion intensity and an excess air
14 ratio that is carefully controlled to limit the
15 radiant burner surface temperature to less than 2000°F,
16 and preferably in the range of 1500°F to 1900°F, in
17 order to provide extended life for the radiant burner.

18 In each embodiment, the catalyst particle
19 diameters and reactant mass velocities are carefully
20 controlled to simultaneously limit the reactor
21 pressure drop to less than 8 psi, and preferably in
22 the range of 2 psi to 4 psi in order to limit the